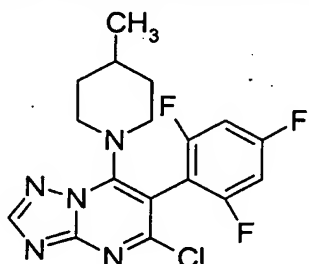


Fungicidal mixtures

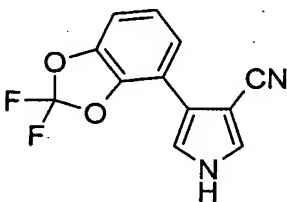
The present invention relates to fungicidal mixtures comprising, as active components,

- 5 1) the triazolopyrimidine of the formula I,



and

- 10 2) fludioxonil of the formula II,



in a synergistically effective amount.

- 15 Moreover, the invention relates to a method for controlling harmful fungi using mixtures of the compound I with the compound II and to the use of the compound I with the compound II for preparing such mixtures and compositions comprising these mixtures.

- 20 The compound I, 5-chloro-7-(4-methylpiperidin-1-yl)-6-(2,4,6-trifluorophenyl)-[1,2,4]triazolo[1,5-a]pyrimidine, its preparation and its action against harmful fungi are known from the literature (WO 98/46607).

Mixtures of triazolopyrimidines with other active compounds are known from EP-A 988 790 and US 6 268 371.

- 25 The compound of the formula II, 4-(2,2-difluorobenzo[1,3]dioxol-4-yl)-1H-pyrrole-3-carbonitrile, its preparation and its action against harmful fungi are also known (The Pesticide Manual, Ed. The British Crop Protection Council, 10th edition (1995), p. 482; common name: fludioxonil).

It is an object of the present inventions, with a view to effective control of phytopathogenic harmful fungi, at application rates which are as low as possible, to provide mixtures which, at a reduced amount of active compounds applied, have improved action against a broad spectrum of harmful fungi (synergistic mixtures).

5

We have found that this object is achieved by the mixtures defined at the outset. Moreover, we have found that simultaneous, that is joint or separate, application of the compound I and the compound II or successive application of the compound I and the compound II allows better control of harmful fungi than is possible with the individual compounds.

10

When preparing the mixtures, it is preferred to employ the pure active compounds I and II, to which further active compounds against harmful fungi or against other pests, such as insects, arachnids or nematodes, or else herbicidal or growth-regulating active compounds or fertilizers can be added according to need.

15

Other suitable active compounds in the above sense are in particular fungicides selected from the following group:

20

- acylalanines, such as benalaxyl, ofurace or oxadixyl,
- amine derivatives, such as aldimorph, dodemorph, fenpropidin, guazatine, iminocadine, tridemorph,
- anilinopyrimidines, such as pyrimethanil, mepanipyrim or cyprodinyl,
- antibiotics, such as cycloheximide, griseofulvin, kasugamycin, natamycin, polyoxin or streptomycin,

25

- azoles, such as bitertanol, bromoconazole, cyproconazole, difenoconazole, dinitroconazole, enilconazole, fenbuconazole, fluquinconazole, flusilazole, flutriafol, hexaconazole, imazalil, ipconazole, myclobutanil, penconazole, propiconazole, prochloraz, prothioconazole, simeconazole, tetraconazole, triadimefon, triadimenol, triflumizole, triticonazole,

30

- dicarboximides, such as myclozolin, procymidone,
- dithiocarbamates, such as ferbam, nabam, metam, propineb, polycarbamate, ziram, zineb,
- heterocyclic compounds, such as anilazine, boscalid, carbendazim, oxycarboxin, cyazofamid, dazomet, famoxadone, fenamidone, fuberidazole, flutolanil, furametpyr, isoprothiolane, mepronil, nuarimol, probenazole, pyroquilon, silthiofam, thia-bendazole, thifluzamide, tiadinil, tricyclazole, triforine,

35

- nitrophenyl derivatives, such as binapacryl, dinocap, dinobuton, nitrophthal-isopropyl,

40

- phenylpyrroles, such as fenpiclonil

- other fungicides, such as acibenzolar-S-methyl, carpropamid, chlorothalonil, cyflufenamid, cymoxanil, diclomezine, diclocymet, diethofencarb, edifenphos, ethaboxam, fentin-acetate, fenoxanil, ferimzone, fosetyl, hexachlorobenzene, metrafenone, pencycuron, propamocarb, phthalide, tolclofos-methyl, quintozone, zoxamide,
- 5 • strobilurins, such as fluoxastrobin, metominostrobin, orysastrobin, pyraclostrobin,
- sulfenic acid derivatives, such as captafol,
- cinnamides and analogous compounds, such as flumetover.

10 Suitable components III and IV are in particular the anilinopyrimidines, such as pyrimethamil, mepanipyrim or cyprodinil, in particular cyprodinil. Preference is given to mixtures of the compounds I and II with a component III. Particular preference is given to mixtures of the compounds I and II.

15 The mixtures of the compound I and the compound II or the simultaneous (joint or separate) use of the compound I and the compound II are distinguished by an outstanding effectiveness against a broad spectrum of phytopathogenic fungi, especially from the classes of the *Ascomycetes*, *Deuteromycetes*, *Oomycetes* and *Basidiomycetes*. They can be used in crop protection as foliar and soil fungicides.

20 They are particularly important in the control of a multitude of fungi on various cultivated plants, such as bananas, cotton, vegetable species (for example cucumbers, beans and cucurbits), barley, grass, oats, coffee, potatoes, corn, fruit species, rye, soya, tomatoes, grapevines, wheat, ornamental plants, sugar cane, a large number of seeds and in particular rice.

25 They are especially suitable for controlling the following phytopathogenic fungi:
Blumeria graminis (powdery mildew) on cereals, *Erysiphe cichoracearum* and *Sphaerotheca fuliginea* on cucurbits, *Podosphaera leucotricha* on apples, *Uncinula necator* on grapevines, *Puccinia* species on cereals, *Rhizoctonia* species on cotton, rice and
 30 lawns, *Ustilago* species on cereals and sugar cane, *Venturia inaequalis* on apples, *Bipolaris* and *Drechslera* species on cereals, rice and lawns, *Septoria nodorum* on wheat, *Botrytis cinerea* on strawberries, vegetables, ornamental plants and grapevines, *Mycosphaerella* species on bananas, peanuts and cereals, *Pseudocercospora herpotrichoides* on wheat and barley, *Phytophthora infestans* on potatoes and tomatoes,
 35 *Pseudoperonospora* species on cucurbits and hops, *Plasmopara viticola* on grapevines, *Alternaria* species on fruit and vegetables and also *Fusarium* and *Verticillium* species.

40 Owing to the special cultivation conditions of rice plants, the requirements that a rice fungicide has to meet are considerably different from those that fungicides used in ce-

real or fruit growing have to meet. There are differences in the application method: in modern rice cultivation, in addition to foliar application, which is usual in many places, the fungicide is applied directly onto the soil during or shortly after sowing. The fungicide is taken up into the plant via the roots and transported in the sap of the plant to the plant parts to be protected. In contrast, in cereal or fruit growing, the fungicide is usually applied onto the leaves or the fruits; accordingly, in these crops the systemic action of the active compounds is considerably less important.

Moreover, rice pathogens are typically different from those in cereals or fruit. *Pyricularia oryzae* and *Corticium solani* (syn. *Rhizoctonia sasakii*) are the pathogens of the diseases most prevalent in rice plants. *Rhizoctonia sasakii* is the only pathogen of agricultural significance from the sub-class *Agaricomycetidae*. In contrast to most other fungi, this fungus attacks the plant not via spores but via a mycelium infection.

They are of particular importance for controlling harmful fungi on rice plants and seeds thereof, such as *Bipolaris* and *Drechslera* species, and also *Pyricularia oryzae*. They are particularly suitable for the control of brown spot of rice caused by *Cochliobolus miyabeanus*.

They can also be used in the protection of materials (e.g. the protection of wood), for example against *Paecilomyces variotii*.

The compound I and the compound II can be applied simultaneously, that is jointly or separately, or in succession, the sequence, in the case of separate application, generally not having any effect on the result of the control measures.

The compound I and the compound II are usually applied in a weight ratio of from 100:1 to 1:100, preferably from 10:1 to 1:10, in particular from 5:1 to 1:5.

The components III and, if appropriate, IV are, if desired, added in a ratio of from 20:1 to 1:20 to the compound I.

Depending on the type of compound and the desired effect, the application rates of the mixtures according to the invention are from 5 g/ha to 2000 g/ha, preferably from 50 to 1500 g/ha, in particular from 50 to 750 g/ha.

Correspondingly, the application rates for the compound I are generally from 1 to 2000 g/ha, preferably from 10 to 1000 g/ha, in particular from 20 to 750 g/ha.

Correspondingly, the application rates for the compound II are generally from 1 to 1000 g/ha, preferably from 10 to 750 g/ha, in particular from 20 to 500 g/ha.

5 In the treatment of seed, application rates of mixture are generally from 0.1 to 100 g/100 kg of seed, preferably from 1 to 50 g/100 kg, in particular from 1 to 10 g/100 kg.

10 In the control of phytopathogenic harmful fungi, the separate or joint application of the compound I and the compound II or of the mixtures of the compound I and the compound II is carried out by spraying or dusting the seeds, the plants or the soils before or after sowing of the plants or before or after emergence of the plants. The compounds I and II are preferably applied by spraying the leaves.

15 The mixtures according to the invention, or the compounds I and II, can be converted into the customary formulations, for example solutions, emulsions, suspensions, dusts, powders, pastes and granules. The use form depends on the particular intended purpose; in each case, it should ensure a fine and even distribution of the compound according to the invention.

20 The formulations are prepared in a known manner, for example by extending the active compound with solvents and/or carriers, if desired using emulsifiers and dispersants. Solvents/auxiliaries suitable for this purpose are essentially:

- 25 - water, aromatic solvents (for example Solvesso products, xylene), paraffins (for example mineral oil fractions), alcohols (for example methanol, butanol, pentanol, benzyl alcohol), ketones (for example cyclohexanone, gamma-butyrolactone), pyrrolidones (NMP, NOP), acetates (glycol diacetate), glycols, fatty acid dimethylamides, fatty acids and fatty acid esters. In principle, solvent mixtures may also be used,
- 30 - carriers such as ground natural minerals (for example kaolins, clays, talc, chalk) and ground synthetic minerals (for example highly disperse silica, silicates); emulsifiers such as nonionic and anionic emulsifiers (for example polyoxyethylene fatty alcohol ethers, alkylsulfonates and arylsulfonates) and dispersants such as lignosulfite waste liquors and methylcellulose.

35 Suitable surfactants used are alkali metal, alkaline earth metal and ammonium salts of lignosulfonic acid, naphthalenesulfonic acid, phenolsulfonic acid, dibutyl naphthalenesulfonic acid, alkylarylsulfonates, alkyl sulfates, alkylsulfonates, fatty alcohol sulfates, fatty acids and sulfated fatty alcohol glycol ethers, furthermore condensates of sulfonated naphthalene and naphthalene derivatives with
40 formaldehyde, condensates of naphthalene or of naphthalenesulfonic acid with phenol

and formaldehyde, polyoxyethylene octylphenyl ether, ethoxylated isooctylphenol, octylphenol, nonylphenol, alkylphenyl polyglycol ethers, tributylphenyl polyglycol ether, tristearylphenyl polyglycol ether, alkylaryl polyether alcohols, alcohol and fatty alcohol ethylene oxide condensates, ethoxylated castor oil, polyoxyethylene alkyl ethers, 5 ethoxylated polyoxypropylene, lauryl alcohol polyglycol ether acetal, sorbitol esters, lignosulfite waste liquors and methylcellulose.

Substances which are suitable for the preparation of directly sprayable solutions, emulsions, pastes or oil dispersions are mineral oil fractions of medium to high boiling 10 point, such as kerosene or diesel oil, furthermore coal tar oils and oils of vegetable or animal origin, aliphatic, cyclic and aromatic hydrocarbons, for example toluene, xylene, paraffin, tetrahydronaphthalene, alkylated naphthalenes or their derivatives, methanol, ethanol, propanol, butanol, cyclohexanol, cyclohexanone, isophorone, highly polar solvents, for example dimethyl sulfoxide, N-methylpyrrolidone or water.

15 Powders, materials for spreading and dustable products can be prepared by mixing or concomitantly grinding the active substances with a solid carrier.

Granules, for example coated granules, impregnated granules and homogeneous 20 granules, can be prepared by binding the active compounds to solid carriers. Examples of solid carriers are mineral earths such as silica gels, silicates, talc, kaolin, attaclay, limestone, lime, chalk, bole, loess, clay, dolomite, diatomaceous earth, calcium sulfate, magnesium sulfate, magnesium oxide, ground synthetic materials, fertilizers, such as, for example, ammonium sulfate, ammonium phosphate, ammonium nitrate, ureas, and 25 products of vegetable origin, such as cereal meal, tree bark meal, wood meal and nutshell meal, cellulose powders and other solid carriers.

In general, the formulations comprise from 0.01 to 95% by weight, preferably from 0.1 to 90% by weight, of the active compounds. The active compounds are employed in a 30 purity of from 90% to 100%, preferably 95% to 100% (according to NMR spectrum).

The following are examples of formulations: 1. Products for dilution with water

A) Water-soluble concentrates (SL)

35 10 parts by weight of the active compounds are dissolved in water or in a water-soluble solvent. As an alternative, wetters or other auxiliaries are added. The active compound dissolves upon dilution with water.

B) Dispersible concentrates (DC)

20 parts by weight of the active compounds are dissolved in cyclohexanone with addition of a dispersant, for example polyvinylpyrrolidone. Dilution with water gives a dispersion.

5 C) Emulsifiable concentrates (EC)

15 parts by weight of the active compounds are dissolved in xylene with addition of calcium dodecylbenzenesulfonate and castor oil ethoxylate (in each case 5% strength). Dilution with water gives an emulsion.

10 D) Emulsions (EW, EO)

40 parts by weight of the active compounds are dissolved in xylene with addition of calcium dodecylbenzenesulfonate and castor oil ethoxylate (in each case 5% strength). This mixture is introduced into water by means of an emulsifying machine (Ultraturrax) and made into a homogeneous emulsion. Dilution with water gives an emulsion.

15

E) Suspensions (SC, OD)

In an agitated ball mill, 20 parts by weight of the active compounds are comminuted with addition of dispersants, wetters and water or an organic solvent to give a fine active compound suspension. Dilution with water gives a stable suspension of the active compound.

20

F) Water-dispersible granules and water-soluble granules (WG, SG)

50 parts by weight of the active compounds are ground finely with addition of dispersants and wetters and prepared as water-dispersible or water-soluble granules by means of technical appliances (for example extrusion, spray tower, fluidized bed). Dilution with water gives a stable dispersion or solution of the active compound.

25

G) Water-dispersible powders and water-soluble powders (WP, SP)

75 parts by weight of the active compounds are ground in a rotor-stator mill with addition of dispersants, wetters and silica gel. Dilution with water gives a stable dispersion or solution of the active compound.

30

2. Products to be applied undiluted

35 H) Dustable powders (DP)

5 parts by weight of the active compounds are ground finely and mixed intimately with 95% of finely divided kaolin. This gives a dustable product.

I) Granules (GR, FG, GG, MG)

0.5 part by weight of the active compounds is ground finely and associated with 95.5% carriers. Current methods are extrusion, spray-drying or the fluidized bed. This gives granules to be applied undiluted.

5 J) ULV solutions (UL)

10 10 parts by weight of the active compounds are dissolved in an organic solvent, for example xylene. This gives a product to be applied undiluted.

The active compounds can be used as such, in the form of their formulations or the use
10 forms prepared therefrom, for example in the form of directly sprayable solutions, powders, suspensions or dispersions, emulsions, oil dispersions, pastes, dustable products, materials for spreading, or granules, by means of spraying, atomizing, dusting, spreading or pouring. The use forms depend entirely on the intended purposes; they are intended to ensure in each case the finest possible distribution of
15 the active compounds according to the invention.

Aqueous use forms can be prepared from emulsion concentrates, pastes or wettable
powders (sprayable powders, oil dispersions) by adding water. To prepare emulsions,
20 pastes or oil dispersions, the substances, as such or dissolved in an oil or solvent, can be homogenized in water by means of a wetter, tackifier, dispersant or emulsifier. However, it is also possible to prepare concentrates composed of active substance, wetter, tackifier, dispersant or emulsifier and, if appropriate, solvent or oil, and such concentrates are suitable for dilution with water.

25 The active compound concentrations in the ready-to-use preparations can be varied within relatively wide ranges. In general, they are from 0.0001 to 10%, preferably from 0.01 to 1%.

30 The active compounds may also be used successfully in the ultra-low-volume process (ULV), it being possible to apply formulations comprising over 95% by weight of active compound, or even to apply the active compound without additives.

Oils of various types, wetters, adjuvants, herbicides, fungicides, other pesticides, or
bactericides may be added to the active compounds, even, if appropriate, not until
35 immediately prior to use (tank mix). These agents are typically admixed with the compositions according to the invention, in a weight ratio from 1:10 to 10:1.

The compounds I and II or the mixtures or the corresponding formulations are applied
by treating the harmful fungi, the plants, seeds, soils, areas, materials or spaces to be
40 kept free from them with a fungicidally effective amount of the mixture or, in the case of

separate application, of the compounds I and II. Application can be carried out before or after infection by the harmful fungi.

5 The fungicidal action of the compound and of the mixtures can be demonstrated by the following experiments:

The active compounds, separately or jointly, were prepared as a stock solution comprising 0.25% by weight of active compound in acetone or DMSO. 1% by weight of the emulsifier Uniperol® EL (wetting agent having emulsifying and dispersant action based on ethoxylated alkylphenols) was added to this solution, and the mixture was
10 diluted with water to the desired concentration.

Use example 1 – activity against brown spot of rice caused by *Cochliobolus miyabeanus*, protective application
15

Leaves of potted rice seedlings of the cultivar "Tai-Nong 67" were sprayed to runoff point with an aqueous suspension of the concentration of active compound stated below. The next day, the plants were inoculated with an aqueous spore suspension of *Cochliobolus miyabeanus*. The test plants were then placed in climatized chambers at 22 - 24°C and
20 95 - 99 % relative atmospheric humidity for six days. The extent of the development of the infection on the leaves was then determined visually.

Evaluation was carried out by determining the percentage of infected leaf area. These percentages were converted into efficacies.
25

The efficacy (E) is calculated as follows using Abbot's formula:

$$E = (1 - \alpha/\beta) \cdot 100$$

30 α corresponds to the fungicidal infection of the treated plants in % and
 β corresponds to the fungicidal infection of the untreated (control) plants in %

An efficacy of 0 means that the infection level of the treated plants corresponds to that of the untreated control plants; an efficacy of 100 means that the treated plants are not
35 infected.

The expected efficacies of mixtures of active compounds are determined using Colby's formula (R.S. Colby, Weeds, 15, 20-22, 1967) and compared with the observed efficacies.
40

Colby's formula:

$$E = x + y - x \cdot y / 100$$

5 E expected efficacy, expressed in % of the untreated control, when using the mixture of the active compounds A and B at the concentrations a and b

x efficacy, expressed in % of the untreated control, when using the active compound A at the concentration a

10

y efficacy, expressed in % of the untreated control, when using the active compound B at the concentration b

Table A – individual active compounds

| Ex-ample | Active compound | Concentration of active compound in the spray liquor [ppm] | Efficacy in % of the untreated control |
|----------|---------------------|--|--|
| 1 | control (untreated) | - | (90 % infection) |
| 2 | I | 4 | 33 |
| 3 | II (fludioxonil) | 4 1 | 33 0 |

15

Table B – Mixtures according to the invention

| Ex-ample | Mixture of active compounds Concentration Mixing ratio | Observed efficacy | Calculated efficacy*) |
|----------|--|-------------------|-----------------------|
| 4 | I + II 4 + 1 ppm 4:1 | 83 | 33 |
| 5 | I + II 4 + 4 ppm 1:1 | 94 | 56 |

*) efficacy calculated using Colby's formula

Use example 2 – activity against sheath blight on rice caused by *Corticium sasakii*

20

Pots with rice plants of the cultivar "Tai-Nong 67", were sprayed to runoff point with an aqueous suspension having the concentration of active compounds stated below. The next day, oat grains infected with *Corticium sasakii* were placed into the pots (in each case 5 grains per pot). The plants were then placed in a chamber at 26°C and maximum

atmospheric humidity. After 11 days, the sheath blight on the untreated but infected control plants had developed to such an extent that the infection could be determined visually in %.

- 5 Evaluation was carried out analogously to Example 1.

Table C – individual active compounds

| Ex-ample | Active compound | Concentration of active compound in the spray liquor [ppm] | Efficacy in % of the untreated control |
|----------|---------------------|--|--|
| 6 | control (untreated) | - | (95 % infection) |
| 7 | I | 4 | 37 |
| 8 | II (fludioxonil) | 4 | 6 |
| | | 1 | 0 |

Table D – Mixtures according to the invention

| Ex-ample | Mixture of active compounds Concentration Mixing ratio | Observed efficacy | Calculated efficacy*) |
|----------|--|-------------------|-----------------------|
| 9 | I + II 4 + 1 ppm 4:1 | 84 | 37 |
| 10 | I + II 4 + 4 ppm 1:1 | 90 | 41 |

- 10 *) efficacy calculated using Colby's formula

The test results show that for all mixing ratios the observed efficacy is higher than that predicted using Colby's formula.